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ABSTRACT

This chapter presents the following discussions on the issues of interpretive research: (1) finding quality criteria that pertain to the quality of interpretive research; (2) determining authenticity criteria for interpretive research; and (3) and providing an example of the procedures employed and the outcomes of an intensive interpretive study undertaken by McRobbie and Tobin in an Australian high school. (KHR)

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18 Interpretive Research in Science Education

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Interpretive research is an umbrella term used to describe studies that endeavor to understand a community in terms of the actions and interactions of the participants, from their own perspectives. Interpretive research seeks to answer broad questions and can address sociocultural factors not accessed easily using other methodologies. For example, the first interpretive study undertaken by our research group investigated the question of what is happening in high school science classrooms. Initially our explanations of what was happening were related to patterns that could be observed directly by members of our research team (Tobin & Gallagher, 1987). We identified numerous factors that shaped the science curricula being taught, such as students who monopolized interactions with the teacher, gender equity issues, and the nature of the assessment system (Tobin, Espinet, Byrd, & Adams, 1988). Gradually our foci shifted to patterns that related teachers' beliefs to the enacted science curricula (Tobin & Espinet, 1989). The study of teachers' beliefs then evolved to include the role of metaphor in constraining teachers' and students' actions (Briscoe, 1993; Tobin, Kahle, & Fraser, 1990; Tobin & LaMaster, 1995; Tobin & Tippins, 1996). As a landscape of understandings about teaching and learning emerged, we began to examine the manner in which specific subject matter was taught in a context of the social forces that distribute power and constrain the actions of participants in a community (Tobin, McRobbie, & D. Anderson, 1997). Throughout this succession of studies, I worked with my colleagues to explore the potential of interpretive research and to develop forms of practice in which the epistemology associated with the

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actions and interactions of the researcher was compatible with that applied to the interpretive frame used to construct and explain data.

What I find most appealing about interpretive research are its flexibility to explore the issues of greatest salience in a particular setting and the emergent nature of the design. Of most importance are the meanings that researchers assign to experiences in the field. The design of a study at any time depends on what is being learned, the questions that guide the design being: What is known now? and What do we want to learn next? Any visit to the field can take into account what has been learned in a study already. Therefore, the critical components of the design of an interpretive study are its emergent nature and, as the study progresses, the provision of sufficient time for interpretation.

The following sections present discussions of:

- The criteria that pertain to the quality of interpretive research.
- Authenticity criteria.
- An example of the procedures employed and the outcomes of an intensive interpretive study undertaken by McRobbie and me in an Australian high school (e.g., McRobbie & Tobin, 1995; Tobin & McRobbie, 1996a, 1996b).

QUALITY CRITERIA FOR INTERPRETIVE RESEARCH

Because interpretive research acknowledges its subjectivity, it does not follow that everything is permissible and that there are no standards. On the contrary, as noted already, an interpretive researcher seeks to learn through systematic activity focused on efforts to understand the interactions between participants in social settings in terms of the perspectives of the participants. The "re" in research is important in that researchers not only seek to know but also are skeptical about what is learned; therefore, they look again in a search for evidence to counter the assertions of a study. That is, the knowledge gained from research is put to the test so that there is a close link between what is learned and the evidence used to support claims made from a study. The standards that apply to interpretive research and ensure that it is a credible and moral activity are described in this section.

Getting Started

Although the tradition in research has been to concentrate on the identification of patterns or major trends, that is, the central tendencies, and to regard divergence from the central position as error, the underpinnings of interpretive research mandate that we learn not only from central tendencies but also from data sources at the periphery of a community. In interpretive research, efforts are made to get a clear picture of the central tendencies and to understand the phenomena that are discrepant from the patterns of central tendencies. This principle is enshrined in the design of interpretive research by selecting participants serially and contingently. Accordingly, binding decisions are not made beforehand about who will participate in a study or how many participants will be involved. Having started with one participant, extensive observations can reveal certain patterns that become foci of interest. When the substantive issues suggest that it is time to add another participant, then that participant should be selected to provide experiences that will advance our understandings of the issues on which the research is centered. One criterion that often is employed is to choose someone who is most different from the first participant selected and studied. In other words, a dialectical principle is applied in the selection of participants so that the diversity of a given community is reflected in the data sources scrutinized during a study.

In an interpretive study of the teaching and learning of college physics, we were interested in examining the nature of learning environments in the class. The context for the study was a course for science education majors who were seeking certification in a science area other than physics. Any community involves a relatively large number of participants who are concerned about what is happening in their area of interest. These participants tend to cluster into groups such as students, teachers, administrators, parents, and business representatives. It is important to identify those concerned who will be regarded as sources of data. Usually, it is not possible to include all of the stakeholder groups in a study, so it is necessary to pick the most salient ones to participate. Which groups to include and which to leave out can become clearer as a study progresses. I try to concentrate initially on only the essential primary data sources and include others as a study becomes more focused. In this example of the college physics class, those most affected by the outcome were the professor and the students. So only they were chosen at the outset. This decision was based on what we judged to be the best use of scarce human resources on the research team. We preferred to reserve our resources for intensive case

studies of relatively few individuals rather than less intensive activities with a larger number of participants.

Selecting the students for the study necessitated careful consideration of a number of alternatives. First we identified a female undergraduate, Diedre, who was struggling with the scientific content covered in the class. She was very determined to succeed and had shown that she was willing to seek outside assistance and to make extra efforts. Her selection would enable us to see how she made sense of physics and would provide a window into the problems she encountered. Furthermore, we believed that her participation could help her to learn physics through her conversations with the researchers about the subject matter. The student who was most different from Diedre was Joel, an undergraduate student who had attained the highest scores on the initial assessment tasks. A third choice was selected as a potential participant. He was as different from Joel and Diedre as possible, a man who was not succeeding and who frequently made self-demeaning remarks.

The three participants were all approachable and occupied different places in the classroom community. Although we felt that three students would be an ample number, we selected a fourth who we thought was closer to the center of the group in that he was regarded as typical. We then commenced an intensive analysis of Diedre's participation in the study, including the others as secondary sources whenever we felt a need to test the diversity of the students' beliefs on issues that emerged from our interpretations. By adopting this approach, we were able to place Diedre in relation to the others on issues that she regarded as critical to her learning. After several weeks of intensive research, we handed our interpretive remarks to Diedre for her comments and began a case study of Joel. At this stage, the study took a sudden turn because of an incident involving Joel.

Because of his dissatisfaction with how the students were building a scientific discourse, the professor reorganized them into heterogeneous groups of four for discussion. During the first discussion, it was apparent that Joel did not appreciate being in a group with someone like Diedre, who was not learning at the same rate. Joel did not think that her explanations to Diedre were pertinent to her own goals as a learner, regarded additional discussions as counter to her best interests, and left the group to join others who she perceived were working at a more appropriate pace. Her actions stunned the professor and the other students in her group. Subsequent analysis of the incident revealed dramatic differences among the participants in

their beliefs about learning and the importance of different roles and activities. Diedre, Joel, and the professor remained key data sources along with the other students in the group of four, both of whom were not identified in the original set of four participants.

Significant issues in any study are identifying appropriate hypotheses and ensuring that suitable data are obtained to test them in a credible manner. For this reason, it is important to stay on top of the analysis and interpretation of data. Unlike other forms of research in which analysis and interpretation follow data collection in a linear way, interpretive research requires that continuing interpretations permit successive assumptions on which the design of a study is built. Thus, the principles of an emergent design require ongoing analysis and interpretation, and successive assumptions permit the agendas of researchers to reflect what appear to be the most salient issues. However, it is important not only to recognize that an emergent design permits interpretive research to be responsive to what happens in the classroom but also to acknowledge that what is noticed in the events of the field will reflect the values and personal history of the researcher. Similarly, what is not noticed or what is regarded as unimportant also will reflect a value system of the observer. Accordingly, an account of the theoretical frame of the observer is of crucial importance in interpretive research. Of course it is difficult to know about this, and, as a study progresses, it is likely to change. Therefore, it is important that researchers record those beliefs that they think are of most significance to devising and carrying out a study. These beliefs, once recorded, can be referents for reflection and critical analysis by researchers, who ought to be aware of the ways in which their beliefs are affecting the formulation of a study. Discussion of them might lead to the identification of other beliefs, hitherto intuitive, that also are framing their perspectives.

Data Sources

The data of a study emerge from analysis of their sources, which, in turn, are selected for their potential alignment with the goals of the research. Qualitative data sources can take many forms that include, but are not limited to:

- Transcripts of oral texts.
- Videotaped images of teaching and learning.
- Photographs of classroom events and phenomena.
- Sketches and diagrams from the field.
- Artifacts collected from the classroom or school.

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- Field notes and analytical memoranda related to observations of teaching and learning or visits to the site of the study (i.e., the field).

An interpretive study would employ a variety of data sources in order to increase the credibility of what is learned, and it is expected that multiple data sources would support any assertion.

Multiple data sources need to be explored in order to establish the warrants for knowledge claims. If multiple data sources produce a pattern that makes sense, then there is greater confidence that the pattern is not dependent on a particular form of data, such as field notes or interviews. Also related to credibility is prolonged engagement in the field. Here, the interest is to ensure that patterns persist over time and are not idiosyncratic of events at a particular time. The framing of data over time needs to take place in a context of the changing perspectives of the researcher, which also ought to be documented over the same period. In addition, intensive investigation of the phenomena of the study ought to occur. The intention is that such intensive observations will facilitate the detailed description necessary to contextualize what is learned from an interpretive study.

Creating Viable Assertions

Having accessed a variety of data sources, the next task of an interpretive researcher is to prepare them for analysis and interpretation. The first challenges are to create an archival system for each source (so that it can be accessed as necessary) and to enable analyses and interpretations to be linked to their original sources.

The preparation of research texts from data sources depends in large part on the nature of the source. Several examples are discussed so that some of the issues can be illustrated.

Field Notes. Generally, notes taken in the field are usually reworked as soon as possible after a researcher returns from the field. At this time, while the memories of events are fresh, details can be added to the written notes and interpretive accounts can be added as analytical memoranda. Usually I adopt the practice of adding questions to the field notes so that, when I get time I can have some of the participants review my notes, read the questions, and clarify items that might need their insights.

Transcriptions. A verbatim transcription is made of segments of interviews and sections deemed irrelevant are deleted. Transcriptions also are made of segments of videotapes. To the

extent possible, notations are used to link the lines of transcribed text with the place on the tape whence it was transcribed. This can save time when it is necessary to refer to primary sources to obtain additional information.

Artifacts From the Field. Documents, photographs, and objects often are brought from field sites because of their potential relevance to a project. In each case, it is useful to link some text to these sources. In most instances, an analytical memorandum is written for each artifact, and documents and photographs can be transformed into a digitized form to permit storage, analysis, and inclusion in interpretive texts.

The first step I take in analyzing a field text is to read it and make notes on a paper copy or on a notepad in my computer. This preliminary analysis is tentative and allows me to obtain an overview of the potential of the data source and how it fits with earlier analyses I have undertaken in this and other studies. This initial reading allows me to prepare the field text in ways that will facilitate subsequent analyses. One task is to identify textual units that are relatively coherent in that they deal with only one issue. Occasionally textual units are less than one complete sentence; usually, they involve one or more sentences. Even if a textual unit is coherent and only represents a single event or a solitary idea, it frequently is possible to classify it according to multiple categories. For example, a textual unit might be an excellent example of both pedagogical content knowledge and gender equity. As I review each textual unit, I create category labels for it and record appropriate descriptors for each category.

When I have read the entire text, I use a word processor to prepare a research text that separates each textual unit from the next with a carriage return. During this process, I edit fully the text. To facilitate analysis with a computer program I save a text file, being sure to delete the soft returns at the end of each line inserted by the word-processing application when the text wraps around automatically at the end of each line in a textual unit. Before beginning subsequent analyses, I ensure that all of the editing is done in a word processor because computer applications for analyzing qualitative data usually do not have well-developed text editors.

The analysis of texts involves several iterations. Most computer applications permit the user to read each unit and assign one or more category labels to it. As I read through each textual unit, I use existing categories to classify the text or I create new categories. When all of the textual units have been classified, most qualitative research programs can provide a

display of the text associated with each category. The subsequent stages in the analysis are to sort the textual units in each category into subcategories and to identify the linkages between categories. This process is interpretive and is an opportunity for different perspectives to clarify alternative groupings within and between categories. Emerging from these analyses are assertions that are claims about the relationships that underlie the decisions to group specific categories and textual units.

Once assertions have been created, they can provide direction for the design of a study. If a study is to be credible, it is imperative that efforts are made to obtain data that are pertinent to each of the emergent assertions. At this stage, researchers will ensure that each assertion is supported by a variety of data sources and that the amount of data in support of an assertion is substantially more than the amount of data that would refute it. Intensive efforts should be made to locate sources whose information might lead to an assertion being rejected or adapted. By grouping assertions, it is possible to create theoretical entities that are grounded in a study. If the analyses and interpretations have been undertaken with care, it should be possible to link all of the levels of assertions through trails of data to sources that constitute their base of support.

For every pattern that is discernible, there will be discrepant data. A feature of interpretive research is the manner in which discrepant data are investigated thoroughly, so that assertions can be suitably contextualized, elaborated, clarified, and, on some occasions, changed. Negative case analysis operationalizes the significance of maintaining and learning from diversity. A standard to which interpretive researchers might aspire is to understand thoroughly all of the cases that are at variance with a given assertion. An intensive analysis of discrepant cases has the potential to explicate the boundaries of a data set and thereby give added meaning to the assertions that define the central tendencies.

Credibility

Verification of information by the participants in a study is a critical part of an interpretive study. Because one of the goals is to understand the actions of the participants from their own perspectives, researchers are endeavoring to construct texts that address two broad issues: What is happening here? and, What are the reasons for what is happening? In arriving at answers to these questions, there are many levels at which interpretation requires researchers to produce texts that purport to capture the perspectives of participants. Member checks place these

interpretive documents in the hands of participants and ask them to indicate whether or not their perspectives are depicted accurately. Participants might be asked to mark up the text, suggest changes, make elaborations or clarifications, and provide examples to enrich the text. The purposes of member checks are to test the accuracy of researchers' interpretations, by indicating the extent to which participants agree with them. The procedure allows participants to critique the interpretations of the researchers and is an additional source of data for a study. Examples of member checks are the provision of field notes, research texts, and interpretive extracts to participants to review and to indicate specific areas of agreement and disagreement. In the case of young children, we have undertaken such checks orally, explaining to them what we think is happening and why we think it occurred. Their comments are analyzed as member checks. No doubt there will be occasions when researchers will argue that even though a participant claims the researcher has not understood something correctly, an interpretation is retained because of other evidence available to support the assertion. Although the member check is a critical part of interpretive research, the notion that different perspectives can add to the richness of a study permits a researcher to include the differing perspectives on interpretation as another layer of informative description that increases the potential to learn from the investigation. In one study in which a teacher-participant disagreed strongly with the interpretations of our research team, we developed a new research text that included his points of view with ours, evidence for readers that our interpretations and the belief set that supported them were disputed by the teacher (Tobin, et al., 1988).

Erickson (1986) described two challenges for interpretive researchers as making the familiar strange and the strange familiar. The insider's view is essential in an interpretive study and, for that reason, attention is paid to the voices of the participants and such mechanisms as member checks. Those with an insider's view face the challenge of making what is familiar to them seem strange. As necessary as the insiders' perspective might be, it also is essential that a study have an outsider's judgment of what is happening. The outsider's view concerns making the strange seem familiar. More often than not, researchers are from the outside and do not belong to the community that they are studying. Their perspectives are enriched by the theoretical frameworks used to make sense of what they are seeing and to frame what is relevant and noteworthy. An outsider is more likely to notice events that have salience but are accepted as normal practices by an insider and may go unnoticed. An

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interpretive study should incorporate both insiders' and outsiders' perspectives because they are potentially complementary.

One way to include outsiders' perspectives is to use a panel of peers to review interpretations and other aspects of a study in what are referred to as peer debriefing sessions. A critical aspect of peer debriefing is that those involved in it should have no direct interest in the study. Two types of peer groups can be selected: to reflect the research team and to reflect other interest groups. Peer debriefing requires researchers that assemble arguments to support assertions and constitutes a critical check on the viability of what has been learned from a study. When peer committees that reflect specific interest groups are selected, peer debriefing provides opportunities to obtain perspectives held to be viable by different communities. The value of debriefing by one's peers is that new issues and alternative interpretations emerge and require researchers to critique their potential viability. Provided that the researchers learn from them, these perspectives can improve a study.

Preparation of Research Texts

The preparation of research texts is an important part of a study. Many issues have arisen, as we have learned from our practices over the decade, in which I have engaged in interpretive research with a number of my colleagues. The first problem I encountered involved my history of valuing assertions about central tendencies. Accordingly, I organized groups of researchers with an expectation that we would negotiate and arrive at consensus, and my initial studies regarded assertions as being akin to negotiated truths about the settings we studied. After some early problems with members of the research team who were concerned about their inability to convince others of their ways of seeing matters, and many studies in which teachers were affronted by what we wrote about them, I learned an important lesson about diversity.

In a group of researchers, it is not necessary for consensus to be reached on interpretations or on what is to be done next. A group can be a forum for discussing research texts of various types, learning from the perspectives of others, and presenting cogent points of view to peers. In research meetings, it is important to maintain a diversity of interpretations and to identify areas on which there is consensus. We found it necessary to structure research meetings so that all of the researchers could be heard and could participate in a shared discourse in which power was distributed equitably. One of the strengths of having a team of researchers was that the team could be informed from multiple perspectives. Each researcher was afforded an

opportunity to prepare interpretive texts and to subject them to member checks, peer debriefing, and critical analyses by their colleagues engaged in the research. Rather than having one negotiated text, it was considered desirable to have multiple texts and to recognize that different researchers would have different goals and would want to represent those goals and their learning through their participation in research. The differing interpretations of members of a research team were regarded as a strength of a research design, and an essential part of any research text was the acknowledgment that other texts existed representing alternative accounts of what had happened and why it had happened.

The necessity of taking into account the voices of all of the participants in the research setting was a challenge, because an authentic representation of their perspectives might entail relating a story that is of little interest to a researcher. That is to say, the values of teachers that would be represented in their perspectives might differ significantly from those of researchers. In addition, the problems of intertextuality are continual (Lemke, 1995). Researchers pore over documents, such as transcripts from interviews, and identify parts that are relevant and parts that are less relevant to the stories that they want to tell about what they have learned in a study. Relevant textual units are retained and aggregated with others like them into categories that then are associated with one another. In this process, the context in which textual units were given meaning originally can be substantially different because a research text is a rhetorical event in which selected textual units are used as evidence for an assertion that is a part of an emerging thesis that constitutes a research text. A most important aspect of the member-checking process is that the participants have opportunities to review the final research texts as well as the interpretive texts reviewed throughout the study.

The Moral Practice of Research

It is increasingly common for researchers to include teachers among the researchers rather than to design studies where teachers are not a part of the research team. However, whether or not there are teachers on the research team, it is essential that the plans for any study take account of the morality of the interactions between the researchers and the other participants. The researchers should disclose their goals fully and should refrain from developing research agendas that are not understood by all of the participants. Understanding fully what is happening from the perspectives of all of the participants can build from a respect for those perspectives to a realization that the participants interact as they do because they believe that

their actions are viable. Valuing the importance of learning from the perspectives of the participants increases the likelihood that the participants' voices will be elicited and efforts will be made to ensure that the researchers' interpretations bear at least a family resemblance to the participants' descriptions of their own perspectives. Our approach to interpretive research has been guided by an ethical framework proposed initially by Sockett (1993), in which practical wisdom is employed by being fair, caring, honest, and courageous. It is never a matter of displaying one or several of these virtues separately, but of demonstrating practical wisdom that makes full allowance for the contexts in which interactions occur. The plan of a study needs to ensure the morality of all interactions. As a study is conducted, consideration should be given to the dynamic nature and context dependence of the interactions between the participants in a community.

AUTHENTICITY CRITERIA FOR INTERPRETIVE RESEARCH

How much researchers learn from a study is an important authenticity criterion. The researchers' perspectives, used to organize experiences, describe what is happening, and support implications, should evolve in ways that relate to what they are learning from the diverse perspectives of the participants as they (the researchers) come to understand issues that eluded them previously. In this process, it is desirable to obtain interpretive accounts of the perspectives of each of the significant stakeholder groups involved in a study and to check with them that these accounts are similar to what they consider to be their perspectives. This system of member checking enables participants to provide additional data to clarify or elaborate the researcher's efforts to capture their perspectives. Having obtained authentic descriptions of the perspectives of others, it is necessary for researchers to demonstrate that they have learned from them by documenting carefully the issues thought to be salient throughout a study and to show a trajectory of learning over time.

A second measure of authenticity is whether the participants in a study understand and appreciate the constructions and value systems of others, whether they agree with them or not. This measure requires researchers to obtain diverse accounts of the perspectives of stakeholder groups. Once these accounts are available, they can be shared systematically among those concerned with the findings of the study so that the participants not only are aware of the

perspectives of other interest groups but also have opportunities to understand and learn from them. Erickson (1986) suggested that actions be interpreted from the viewpoints of participants and that checks be undertaken to ascertain the extent to which the interpretations of researchers are accepted by participants as authentic descriptions of their perspectives. Member checks, whereby interpretive accounts are returned to stakeholders for comment, are a critical component in assuring that interpretive research provides opportunities for all of the participants to learn from others' perspectives.

Interpretive research is regarded as a catalyst for change. Accordingly, a third test of authenticity concerns the extent to which actions are initiated by participation in a study. The design of a study should anticipate opportunities for strategizing possible changes, examine the potential consequences of enacting particular changes, and plan to study the implementation of changes so that decisions can be made on whether to continue to implement, adapt, or discontinue new practices.

A final authenticity criterion relates to how much the participants in a study are empowered to act. This criterion bears upon the participatory nature of interpretive research and the desire that all stakeholders have significant roles and opportunities to contribute to the study in meaningful ways. The products of the research process, then, should be texts that have been shaped mutually through recursive processes involving negotiation between the researchers and all of the other interested parties. Throughout a study, documents can be released to selected individuals from the most important interest groups so that each is aware of the perspectives of the others and can contemplate changes that might be a consequence of the study. If effective communication is maintained between and within the stakeholder groups it is plausible that consensus can be reached on actions that are acceptable to all concerned.

AN INTERPRETIVE STUDY OF THE TEACHING AND LEARNING OF CHEMISTRY

Transferability

What we learn from interpretive research is grounded in the histories of the researchers. For example, what we learned in the following interpretive study of a veteran chemistry teacher and his class was constrained by the researchers' histories of being science teachers and science

teacher-educators for more than 30 years and having engaged in research in science classrooms for more than 20 years. The extent to which what we learned from this study can be applied to contexts that readers might encounter is constrained by the perspective of the reader and by the potential applications that the reader might consider. In any set of publications, only a part of what has been learned can be reported, and the authors decide how to describe the context of what has been gleaned. In this sense, the authors delimit the extent to which knowledge from a study can be applied by a reader. Accordingly, transferability (Guba & Lincoln, 1989) is viewed as a transaction of a reader with a text, and the extent to which the reader sees the relevance of what has been learned to the problems that he or she has defined.

Social Perspectives

The study incorporated two broad views of social phenomena: actor oriented and structure oriented (Galtung, 1980). Although both perspectives deal with human action and interaction, the actor-oriented position perceives action as related to the intentions and capabilities of the actors whereas the structure oriented position regards action as a function of the position of the actor in a social setting. Thus, the actor-oriented perspective considers actions in terms of the actors' goals, beliefs, behaviors, and constructions of context and the structural perspective examines factors such as diversity, growth, equality, and social justice. The actor-oriented and structural perspectives are conceptualized as existing in a recursive relationship to one another. Neither view is regarded as privileged and each contributes to the description of what is happening and why, the two fundamental foci of interpretive inquiry.

The Setting and Structure

The setting for the study (McRobbie & Tobin, 1995; Tobin & McRobbie, 1996b) was an urban high school with an enrollment of about 1,000 students in Brisbane, Australia. The roles of the researchers were confined, as much as possible, to research. We negotiated entry into the school site to undertake a study that would provide a platform for changes to be considered by the schools' faculty at a later time. The participants in the study were Jacobs (a pseudonym), a 20-year veteran teacher, who also was the chairman of the Science Department, and his Grade 11 chemistry class consisting of nine boys and six girls. We listened with empathy to the stories of the teacher and his students and did not counsel or suggest alternatives. When asked, we assisted students with their learning. Throughout the study, we

did not endeavor to change the teacher's or the students' actions. However, by providing the teacher and the students with field notes, interviewing them, and then giving them transcripts of the interviews, we acknowledge that a context was created in which the reflections of all of the participants were different than would have been the case had we not been there. This was a participant observation study where the presence of the researchers changed what happened although we had not intended that the teacher's and the students' actions would change to fit our goals. As changes occurred, we endeavored to describe and interpret them in a context that took account of our presence.

Two researchers visited the chemistry classroom every day of the week for 4 weeks to observe a unit that explored titrations and electrochemistry. Each lesson was videotaped to facilitate analyses of classroom transactions. Because we were in the field for a prolonged time, the tendency of the participants to exhibit contrived behaviors for the benefit of the researchers was minimized, and we were able to see whether given behaviors were typical or atypical. We maximized the probability that the emergent assertions were consistent with a variety of data through the use of the following sources:

- Field notes and analytical memoranda based on observations of teaching.
- Interviews with Jacobs.
- Interviews with six students, colleague teachers, and administrators.
- Videotaped lesson segments.

Jacobs was interviewed on five occasions, each of about 1 1/2 hours' duration, and six students were interviewed for approximately 1 hour each. The students selected for interview were those identified by the researchers and Jacobs as interesting, in the sense that they represented the diversity of the classroom. We felt that by interviewing these students and observing them intensively, we would come to understand the boundaries of this classroom as well as the central tendencies. The interviews and initial observations revealed that many of the students were immigrants and spoke a language other than English as their mother tongue. More than 20 languages were used by students in the school. English was spoken in the homes of 83% of the students; for 77% percent of them, English was their native tongue. About 10% of the students spoke and wrote English to a limited extent only or hardly at all. In the chemistry class, four of the students had come from Hong Kong or Taiwan. These students informed us that they had elected to study science and mathematics because they felt

their actions are viable. Valuing the importance of learning from the perspectives of the participants increases the likelihood that the participants' voices will be elicited and efforts will be made to ensure that the researchers' interpretations bear at least a family resemblance to the participants' descriptions of their own perspectives. Our approach to interpretive research has been guided by an ethical framework proposed initially by Sockett (1993), in which practical wisdom is employed by being fair, caring, honest, and courageous. It is never a matter of displaying one or several of these virtues separately, but of demonstrating practical wisdom that makes full allowance for the contexts in which interactions occur. The plan of a study needs to ensure the morality of all interactions. As a study is conducted, consideration should be given to the dynamic nature and context dependence of the interactions between the participants in a community.

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How much researchers learn from a study is an important authenticity criterion. The researchers' perspectives, used to organize experiences, describe what is happening, and support implications, should evolve in ways that relate to what they are learning from the diverse perspectives of the participants as they (the researchers) come to understand issues that eluded them previously. In this process, it is desirable to obtain interpretive accounts of the perspectives of each of the significant stakeholder groups involved in a study and to check with them that these accounts are similar to what they consider to be their perspectives. This system of member checking enables participants to provide additional data to clarify or elaborate the researcher's efforts to capture their perspectives. Having obtained authentic descriptions of the perspectives of others, it is necessary for researchers to demonstrate that they have learned from them by documenting carefully the issues thought to be salient throughout a study and to show a trajectory of learning over time.

A second measure of authenticity is whether the participants in a study understand and appreciate the constructions and value systems of others, whether they agree with them or not. This measure requires researchers to obtain diverse accounts of the perspectives of stakeholder groups. Once these accounts are available, they can be shared systematically among those concerned with the findings of the study so that the participants not only are aware of the

perspectives of other interest groups but also have opportunities to understand and learn from them. Erickson (1986) suggested that actions be interpreted from the viewpoints of participants and that checks be undertaken to ascertain the extent to which the interpretations of researchers are accepted by participants as authentic descriptions of their perspectives. Member checks, whereby interpretive accounts are returned to stakeholders for comment, are a critical component in assuring that interpretive research provides opportunities for all of the participants to learn from others' perspectives.

Interpretive research is regarded as a catalyst for change. Accordingly, a third test of authenticity concerns the extent to which actions are initiated by participation in a study. The design of a study should anticipate opportunities for strategizing possible changes, examine the potential consequences of enacting particular changes, and plan to study the implementation of changes so that decisions can be made on whether to continue to implement, adapt, or discontinue new practices.

A final authenticity criterion relates to how much the participants in a study are empowered to act. This criterion bears upon the participatory nature of interpretive research and the desire that all stakeholders have significant roles and opportunities to contribute to the study in meaningful ways. The products of the research process, then, should be texts that have been shaped mutually through recursive processes involving negotiation between the researchers and all of the other interested parties. Throughout a study, documents can be released to selected individuals from the most important interest groups so that each is aware of the perspectives of the others and can contemplate changes that might be a consequence of the study. If effective communication is maintained between and within the stakeholder groups it is plausible that consensus can be reached on actions that are acceptable to all concerned.

AN INTERPRETIVE STUDY OF THE TEACHING AND LEARNING OF CHEMISTRY

Transferability

What we learn from interpretive research is grounded in the histories of the researchers. For example, what we learned in the following interpretive study of a veteran chemistry teacher and his class was constrained by the researchers' histories of being science teachers and science

teacher-educators for more than 30 years and having engaged in research in science classrooms for more than 20 years. The extent to which what we learned from this study can be applied to contexts that readers might encounter is constrained by the perspective of the reader and by the potential applications that the reader might consider. In any set of publications, only a part of what has been learned can be reported, and the authors decide how to describe the context of what has been gleaned. In this sense, the authors delimit the extent to which knowledge from a study can be applied by a reader. Accordingly, transferability (Guba & Lincoln, 1989) is viewed as a transaction of a reader with a text, and the extent to which the reader sees the relevance of what has been learned to the problems that he or she has defined.

Social Perspectives

The study incorporated two broad views of social phenomena: actor oriented and structure oriented (Galtung, 1980). Although both perspectives deal with human action and interaction, the actor-oriented position perceives action as related to the intentions and capabilities of the actors whereas the structure oriented position regards action as a function of the position of the actor in a social setting. Thus, the actor-oriented perspective considers actions in terms of the actors' goals, beliefs, behaviors, and constructions of context and the structural perspective examines factors such as diversity, growth, equality, and social justice. The actor-oriented and structural perspectives are conceptualized as existing in a recursive relationship to one another. Neither view is regarded as privileged and each contributes to the description of what is happening and why, the two fundamental foci of interpretive inquiry.

The Setting and Structure

The setting for the study (McRobbie & Tobin, 1995; Tobin & McRobbie, 1996b) was an urban high school with an enrollment of about 1,000 students in Brisbane, Australia. The roles of the researchers were confined, as much as possible, to research. We negotiated entry into the school site to undertake a study that would provide a platform for changes to be considered by the schools' faculty at a later time. The participants in the study were Jacobs (a pseudonym), a 20-year veteran teacher, who also was the chairman of the Science Department, and his Grade 11 chemistry class consisting of nine boys and six girls. We listened with empathy to the stories of the teacher and his students and did not counsel or suggest alternatives. When asked, we assisted students with their learning. Throughout the study, we

did not endeavor to change the teacher's or the students' actions. However, by providing the teacher and the students with field notes, interviewing them, and then giving them transcripts of the interviews, we acknowledge that a context was created in which the reflections of all of the participants were different than would have been the case had we not been there. This was a participant observation study where the presence of the researchers changed what happened although we had not intended that the teacher's and the students' actions would change to fit our goals. As changes occurred, we endeavored to describe and interpret them in a context that took account of our presence.

Two researchers visited the chemistry classroom every day of the week for 4 weeks to observe a unit that explored titrations and electrochemistry. Each lesson was videotaped to facilitate analyses of classroom transactions. Because we were in the field for a prolonged time, the tendency of the participants to exhibit contrived behaviors for the benefit of the researchers was minimized, and we were able to see whether given behaviors were typical or atypical. We maximized the probability that the emergent assertions were consistent with a variety of data through the use of the following sources:

- Field notes and analytical memoranda based on observations of teaching.
- Interviews with Jacobs.
- Interviews with six students, colleague teachers, and administrators.
- Videotaped lesson segments.

Jacobs was interviewed on five occasions, each of about 1 1/2 hours' duration, and six students were interviewed for approximately 1 hour each. The students selected for interview were those identified by the researchers and Jacobs as interesting, in the sense that they represented the diversity of the classroom. We felt that by interviewing these students and observing them intensively, we would come to understand the boundaries of this classroom as well as the central tendencies. The interviews and initial observations revealed that many of the students were immigrants and spoke a language other than English as their mother tongue. More than 20 languages were used by students in the school. English was spoken in the homes of 83% of the students; for 77% percent of them, English was their native tongue. About 10% of the students spoke and wrote English to a limited extent only or hardly at all. In the chemistry class, four of the students had come from Hong Kong or Taiwan. These students informed us that they had elected to study science and mathematics because they felt

that their lack of proficiency in English would be less of a barrier to their success in these subjects.

Because of the relatively high number of students with limited proficiency in speaking English, we decided to look closely at their performance in chemistry. Initially, we expected to witness their success despite language limitations. This expectation fueled our observations, and it was the use of the hermeneutical dialectical circle that afforded us an opportunity to examine the handicap of limited proficiency in English and the relative importance of cultural capital in assisting students to overcome adverse learning conditions.

Chao (a pseudonym), who immigrated voluntarily to Australia from Hong Kong, was the highest-achieving LEP (limited English proficient) Chinese student in the class. She was selected as the first of two participants in the study because she was older than her peers and, in spite of her limitations with the English language, was easy to talk to and willing to speak with us about her experiences in Australia and Hong Kong. Fortunately for Chao, several of her peers at school were native speakers of Cantonese, and, when necessary, she was able to use Cantonese to clarify and elaborate her chemistry concepts. Chao was successful in Grade 11 but did not complete Grade 12 and returned to Hong Kong for personal reasons. The following year she came back to Australia to complete Grade 12 at a different school in which relatively large numbers of Cantonese speakers and adults were enrolled.

To obtain insights into the differences in the group of LEP Chinese students, we decided to include Poon (a pseudonym) in the study. Poon was chosen because he was quite different from Chao, sat next to and often worked with her, and was a native speaker of Cantonese. Unlike Chao, he was not achieving at a high level, appeared uncertain, and often did not participate in whole-class, verbal interactions because he lacked confidence in speaking English. Poon failed Grade 11, repeated all of the subjects the following year, and passed them all except chemistry. When Poon commenced Grade 12, there were only two Chinese students in Grades 11 and 12: Poon and a male student from Taiwan. As the only speaker of Cantonese, Poon felt isolated and lonely. He rarely spoke to other students, and, although he found them friendly, they often did not speak to him. Thus, his limited proficiency in English minimized his opportunities to learn from his peers.

Data on the teacher's and the students' perceptions of their learning environments were obtained from a 25-item questionnaire referred to as the Classroom Environment Survey

(CES; McRobbie & Tobin, 1997), which ascertained perceptions of the following five constructs:

- The involvement of students in discussions with each other.
- The autonomy of students in making decisions about their learning.
- The relevance of the chemistry subject matter to students' careers and daily lives.
- The commitment of students to learning.
- The inhibitors to learning.

For each dimension, there were parallel questions to measure what the respondents preferred and experienced. The teacher's form of the CES was worded differently from that of the students, asking for his perceptions of the extent of the students' actions. For example, question 1 on the students' form became "Students ask one another about their ideas" on the teacher's form.

The teacher and the students responded to the CES by indicating the extent to which an activity took place in the classroom on a 5-point scale, with intervals representing:

- Very often (assigned scale value of 5; the accompanying description meant that this represented more than once a lesson).
- Often (4; about once a lesson).
- Sometimes (3; weekly).
- Seldom (2; once a month).
- Almost never (1; less than once a month).

On completion of the CES, the teacher and the students were asked to describe aspects of their learning environment in general terms in order to obtain their broad impressions of the classroom. Then they were asked to recount their impressions of their learning environment in terms of involvement, commitment to learning, autonomy, relevance, and disruption. Finally, the respondents were presented with their completed survey forms and asked to explain their responses. This procedure resulted in thick descriptions for each individual at three levels:

- At a holistic level where the students were asked to describe the suitability of the classroom for learning.
- At a level corresponding to each of the five dimensions incorporated in the CES.
- At the specific level of each item in the CES.

These interviews provided ample accounts of the students' and the teacher's learning environments and their preferences. Questions also were posed about the roles of the teacher and students and the nature of the teaching–learning process, their views on the nature of science and scientific knowledge, and the constraining and facilitating aspects of the context.

Jacobs and the students, including Chao and Poon, also were requested to comment on the manner in which LEP Chinese students engaged in tasks, asked for and received help from the teacher and their peers, used resources to assist their learning of chemistry, and interacted with one another and with English-proficient students in the school. Both Chao and Poon were interviewed 2 years after the initial observations in order to check on their educational progress and to provide them with opportunities to review research texts that related to them. Although both of them were limited still in their use of English, they had improved their competence. As was the case during the classroom observations, in comparison to Poon, Chao was more competent and confident in her use of English.

Although we did not measure achievement in learning chemistry in this study, we analyzed performance data used by Jacobs and other teachers of Grade 11 chemistry in the school to assess such achievement. The assessments for the year were based on a summation of performance in four areas: chemistry content, simple application, complex application, and scientific process. We compared the performance in these four areas of 8 LEP Chinese students with 37 English-proficient students in the Grade 11 chemistry cohort.

Throughout the study, my colleague McRobbie and I met regularly to discuss and analyze data and to formulate assertions that provided focal points for subsequent field activities. These focal points reflected our initial interests (the nature of science reflected in the enacted curricula, the teaching and learning of challenging concepts, and teacher's and students' perceptions of the learning environment) and the role of language in the learning of science for students with limited proficiency in English. The latter focus evolved after our curiosity was sparked by the relatively high proportion of Chinese students in the school. Initially, we had assumed that the Chinese would be among the highest achievers in the class based on our stereotypical view that Asian students excel at science.

Any evidence that was counter to an assertion was explored in detail, and care was taken to build an understanding of the discrepancy. In this process, assertions were elaborated to take account of all of the data. Serious attempts were made to refute assertions. The best example

of this involved our initial assertion about Chinese students. This early assumption about high accomplishment needed to allow for Poon's performance; as we focused on his relative lack of success in chemistry, our assertions changed. The focus then shifted to the role of English for those with limited proficiency in it in the context of a country where the instruction is entirely in English.

Data and interpretations were shared with the participants so that they could check intentionality and errors that might have been made either by the participants or the researchers. Extensive member checks allowed the participants to review data and interpretations, agree or disagree with the assertions of the research, and suggest corrections, elaborations, and summary statements. For example, Jacobs was provided with copies of all the field notes, in which we often wrote questions that he answered, written transcripts of four interviews with him, written interpretations of data, and research reports such as papers. Students also were provided with transcripts of their interviews, written interpretations, and copies of draft papers. Reactions from the participants were used as sources of data and provided bases for revising earlier drafts of this chapter.

Over a 2-year period, we continued our association with the participants in the study by asking them to read our interpretations and to suggest changes that would improve the authenticity of our accounts. In addition, in 1995, we shared our interpretations with other students and teachers like those who participated in the study. For example, the narratives of Jacobs, Chao and another student were printed and distributed to another Grade 11 chemistry class taught by Jacobs. Students in these classes were asked to read the narratives and to identify the parts with which they agreed and disagreed. They also were invited to write comments about the narratives.

Drafts of the papers written for the study were distributed to colleagues who had relevant expertise. For example, a paper on limited proficiency in English and the learning of science was distributed to 15 colleagues with backgrounds in science education, English as a second language, or language and literacy. All of them provided critical comments on the paper and 10 attended a peer debriefing session that critiqued our theoretical rationale, procedures, and interpretations. Criticisms raised in the peer debriefing session were used as a basis for numerous changes to that paper (Tobin & McRobbie, 1996a, 1996b).

We decided to use narrative accounts to convey the context of our study and the knowledge that was implicit in the stories of Jacobs, selected students, and the researchers. In this

fashion, we felt that we could emphasize the voices of the teacher and the students in a credible manner and, in the latter parts of another paper emphasize our interpretations. The narrative for Jacobs was an aggregate of segments from interviews with him that were pertinent to the performance of LEP Chinese students and other issues deemed significant by either him or the researchers. Jacobs read and edited the narrative and advised us that it was an authentic report of his beliefs about teaching and learning chemistry. A student narrative was a composite of interviews with several, Australian-born students in the chemistry class. Chao's narrative also was a composite made from transcripts of interviews with her, selected to provide insights into the world of an LEP Chinese student studying chemistry in an Australian school where English is the language for teaching, most learning activities, and assessment. In addition, other narratives were prepared to provide readers with detailed descriptions of our research into teaching and learning. For example, a vignette describing a typical day in the chemistry classroom was based on the field notes of the two researchers for that lesson and on those before and after it, videotapes of the lessons (one that tracked the teacher and the other that concentrated on the learners), and interviews with the teacher and the students about that lesson.

What Did We Learn?

Jacobs made sense of his teaching roles in terms of beliefs related to the transmission of knowledge, being an efficient teacher, maintaining the rigor of the curriculum, and preparing students to be successful on examinations. These beliefs were supported by the teacher and the students and provided a strong rationale for maintaining the types of classroom practices that educational reformers want to change. If teachers can be brought to a level of consciousness about such beliefs as these, there is a chance that their viability can be addressed directly and alternative referents can be generated to propel reform in the direction advocated in the myriad reports that presently exhort changes in educational policy and classroom practice (e.g., National Research Council, 1996).

Although the teacher and his students tended to see science as an evolving discipline that was uncertain and changed over time, the manner in which the curriculum was implemented was a direct contrast. In the enacted curriculum, science was represented as a catalogue of facts to be memorized and as algorithmic solutions to problems. The beliefs that had the greatest impact on shaping the curriculum were the teacher's assumptions of how students learn, his

beliefs about the distribution of power between himself and his students, and the extent to which he accepted restraints as reasons for maintaining a traditional approach to teaching and learning chemistry.

Initially, Jacobs and the students had difficulty describing their beliefs. However, as the study progressed, they used language to recount their practices and to construct mental models that fitted with their practices and beliefs about learning. The teacher's and students' goals, their beliefs about the teacher's and the learners' roles, and their constructions of the context were coherent to such a degree that there was little impetus for change. An objectivist system of semantics was used by the teacher to justify an approach to teaching that was consistent with transmitting knowledge to student-receivers and maintaining a high level of control over their activities. Little autonomy was provided for the students to decide what or how they should learn and chemistry was perceived to have limited relevance.

To a significant measure, the students accepted their learning environment and justified what happened in terms that were consistent with objectivist semantics. Hence, as noted above, there was no motivation to make changes, and the principal concern was to cover the work program in the most efficient way possible. The teacher was in tune with the students' reasons for studying chemistry, and his teaching approaches reinforced their actions. Any endeavor to reform teaching and learning practices should take into account the implications of this congruence between teacher's and students' actions. When teachers and students construct their goals and the contexts in which progress toward those goals will occur, these constructions are not merely a process of mediation between one teacher and his class. The constructions of goals and contexts are saturated with the mediating effects of a cultural press that shapes a referential system that gives meaning to, and criteria for assessing the potential viability of, the actions of either a teacher or a student.

Jacobs' beliefs about the transmission of knowledge, teaching efficiently, and maintaining rigor comprised a coherent array of thoughts that influenced the manner in which he planned his lessons and taught them.

The transmission metaphor views the teacher as a principal source and the students as receivers of knowledge. These beliefs were supported by three dimensions: an objectivist view of knowledge (M. Johnson, 1987), a mental model for teaching and learning that is characterized by memorization, and the conviction that the teacher should have power over the students in most classroom situations. Jacobs also believed that he had the responsibility to

ensure that students learn at a level that is consistent from one set of students to another and from one year to the next. As the guardian of the standards, he considered it his job to maintain the rigor of the chemistry course by covering the prescribed subject matter, nurturing high standards, preparing students for the next educational level, and recognizing that the specification of the curriculum was the prerogative of external agencies.

Because of his beliefs about transmission, efficiency, and rigor, Jacobs made few efforts to elicit reactions from his students and usually was unaware of how they were making sense of what they were to learn. Similarly, because of his beliefs about learning, he did not perceive a role for himself in mediating the construction of linkages in semantic webs of understanding. Even though Jacobs knew his electrochemistry thoroughly, his knowledge probably was based on his extensive teaching experience and did not seem to extend beyond what he needed to know in order to transmit certain facts and perform particular demonstrations. Jacobs did not believe in an interactive model of learning, and for that reason, did not encourage coparticipation. By maintaining a distance from his students and relying on the transmission of facts, he was not conscious of his failure to anticipate probable misconceptions so that he could address them during his activities. In addition, he did not encourage his students to interact to facilitate their learning because he believed that he needed to have control over the coverage of the subject matter to ensure efficient learning and to maintain high standards. Thus, there is an interaction between the subject matter that needs to be known and beliefs about teaching and learning. With few exceptions, Jacobs' pedagogical content knowledge seemed adequate for the restricted roles he played while teaching. However, from the perspective of the roles that he might have filled as a mediator of understanding, his pedagogical content knowledge can be seen as limited. He needed to know not only his facts about electrochemistry but also how to assist his students to demonstrate what they know and how to constrain their experiences such that they build particular canonical understandings.

Two forms of discourse were apparent in Jacobs' class: one associated with the students and the other with Jacobs' voice and canonical science. The extent to which the two forms of discourse overlapped was negligible, even though Jacobs made some efforts to paraphrase and elaborate on students' responses to his questions. Jacobs' concern was to progress through the subject matter, interacting with his students sufficiently so that at least the correct understandings could be provided and ensuring that he completed most of the work planned for

the lesson. The main goals of the lesson were to present correct answers and to cover the content rather than to ensure that the students understood the subject matter. Comprehension of the subject matter was left to the students to accomplish, either as a result of their own thinking during the class or in external settings. Although there are many types of activities that enable students and the teacher to forge a new discourse, each of them would involve the students in being able to create written and oral texts around which interactions, negotiation, and consensus building would occur. It is assumed that all of the participants would, over time, build knowledge that was more scientific.

Despite the efforts to learn of a group of students with limited proficiency in English, their difficulties in speaking and writing English were factors that hampered their ability to learn chemistry with understanding. A shared belief that appeared to permeate the school, that all students should use English to learn chemistry and to demonstrate what they have learned, placed students with little knowledge of English in a position of potential failure. Chinese students tried to use English to make sense of what had happened in class and to demonstrate how much chemistry they had learned. At the same time, they spoke and wrote Cantonese and showed high levels of commitment to learn, make an effort, and remain engaged in productive tasks in and out of school. These practices were consistent with those expected by the teacher and with those that typically occur in schools in their native Hong Kong. The research supports the assertions that learning chemistry can be facilitated when LEP students are given opportunities to use their native language fully and when the microculture of the classroom fits the macroculture of their life outside the classroom.

CONCLUSIONS

To what extent are the products of interpretive research generalizable? Because of the traditions of experimental and quasi experimental research, generalizability has been a concept that has been claimed by researchers when writing about their findings. The warrants for their claims have comprised statistical and logical analyses based on putative links between a sample and a defined population. The argument for generalizability is that the findings of a study, based on a sample, are applicable to the defined population as long as certain criteria are met. Of course, to a reader and a potential user of research, generalizability has little relevance. The credibility

of the research is of most importance and so, too, is the persuasiveness of the argument used to sustain the conclusions. Notwithstanding the extent to which my argument is accepted, many will criticize what is learned from interpretive research on the basis of a small sample size. This inclination has been described by manuscript and proposal reviewers as "the small *N* problem" or "the sample of one phenomenon." To make such statements is to misunderstand a basic goal of interpretive research.

The goals of interpretive research are to make sense of experience, build patterns of meaning and relationship that are linked to well-described situations, and communicate what has been learned in ways that are connected to context. By presenting what has been learned in a context of the evidence for and against the assertions, detailed descriptions of illustrative vignettes, and examples of explanatory data, a text prepared for dissemination can enable a reader to decide how credible and authentic the research is and whether or not anything in the account of it is potentially applicable to the contexts in which he or she practices education. The extent to which what is described in a report is transferable to other contexts or needs to be adapted is for the reader to determine, not the researcher. Thus in preparing research texts, it is important for researchers to provide sufficiently detailed descriptions of the context and the evidence to enable readers to assess the potential transferability and adaptability.

One of the constant problems faced by educational researchers is producing research that can be used by practitioners. Even though the *Journal of Research in Science Teaching* and other journals insisted in the 1970s and 1980s that all articles should include a section on implications for practice, it was generally the case that such journals were not read by teachers and research was not seen as an agent for change and reform as funding agencies and researchers had hoped. If the authenticity criteria described in this chapter are adopted, studies will be planned to make a difference, not only as a result of what is written as a product, but also as a result of the conduct of the research in schools and the moral concern that all of the participants in research should benefit from the activity, not solely the researchers. The belief that knowledge and context are linked inextricably leads to the moral position that research should be designed to be authentic and to produce improvements in the institutions that engage in the research.

A concern that I faced as a beginning researcher in the 1970s and early 1980s was a preoccupation with understanding central tendencies through the partitioning of variance

components. Part of the concern was the linear causal modeling associated with many of the designs I used and a reductionist way of looking at life in complex entities such as classrooms and schools. In addition, an assumption that all of the persons associated with a factor in a design were the same and that any differences were due to random error was problematical for the people I knew. I was not even sure that such an assumption was particularly robust for the agricultural contexts from which many of our statistical approaches had been borrowed. As I explored alternative ways of doing research that would enable me to address meaningful educational problems in a powerful way, interpretive research appealed to me as being most appropriate (Erickson, 1986, 1998). It was legitimate to go to an educational setting and investigate intensively those problems that were of most interest to the participants throughout a study. The questions that could be addressed were significant and the focus was on making sense, not on defining operationally entities that could be controlled and manipulated. After 15 years of research in a paradigm based on quasi-experiments, I was searching for a new methodology and found an appealing alternative in a draft of Erickson's chapter on interpretive research (Erickson, 1986). For me, one of the appealing aspects of interpretive research is that it can be adapted to different, underlying, theoretical referents. Thus, as I have learned more about the social and cultural theories that pertain to the studies in which I engage, I have been able to apply them to the methods I employ in educational research. One referent that has made a considerable difference to how I think about educational research is what Guba and Lincoln (1989) referred to as the hermeneutical dialectical circle.

To my mind the hermeneutical dialectical circle is a way of thinking about the diversity in social settings. Generally, we look for organizations of phenomena in terms of patterns of regularity, and these patterns have been the main quest in educational research. In this chapter, I have referred to them as central tendencies, which often are described in interpretive research as assertions. However, an undue emphasis on central tendencies can favor retention of the existing situations. Use of the hermeneutical dialectical circle can guard against this inclination by going to the opposite extreme. In the selection of participants in a study, one can choose a first participant and then another who is most different from the first. When putting together a research team, one can include different participants so that diverse viewpoints can be represented in the theoretical perspectives that frame the planning and performance of a study. In the interpretation of given data, one can create an assertion and then search for evidence to support an opposite assertion. Thus, use of the hermeneutical dialectical

circle is a factor that enhances the credibility of research and is a guard against the values of a group of interpretive researchers influencing what they choose to notice and to ignore. Finally, application of the hermeneutical dialectical circle ensures that the diversity in an interpretive study will be preserved. Whenever a central tendency is described, a researcher ought to begin to describe the various positions that define the periphery of perspectives that have been identified and preserved as a part of the overall description of the context to which all knowledge is linked.

Research involving human subjects necessarily entails moral actions. Too often in the past, studies have been designed by investigators operating on an assumption that knowledge and context can be separated meaningfully. In this chapter, I have assumed that knowledge and context cannot be separated. Accordingly, the morality of how the research is conducted needs to be considered at all times during a study. The considerations are context-dependent and do not reduce easily to a set of rules that typically govern the performance of research in universities and schools. On the basis of what I have described earlier in this chapter, it might be concluded that a researcher should demonstrate practical wisdom in terms of being honest, courageous, caring, and fair. However, such an exhortation ignores the complexity of most social systems and the paradox that to interact appropriately with one set of participants might be regarded as uncaring or unfair by other sets of participants. Participation in many communities carries with it an inherent ambiguity, especially for outsiders. Accordingly, I conclude this chapter with the suggestion that research be planned and performed with issues of ethical practice kept in the foreground and the subject of ongoing critical discussion throughout the progress of a study. If this becomes widespread practice in educational research, it is possible that those involved will be receptive to enacting changes on the basis of what they learn through their research activity. In such circumstances, the conduct of research will mean much more than the preparation and acceptance of researchers' accounts of their work.

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